

WHAT IS CLAIMED IS:

SUBA17

1 A liquid crystal display apparatus comprising:
a liquid crystal display panel having a predetermined
5 display characteristic;

a luminescent unit located adjacent to the liquid
crystal display panel, wherein the luminescent unit includes
a light collector, which collects ambient light, and a light
source; and

10 a control circuit electrically connected to the liquid
crystal display panel, wherein the control circuit varies
the predetermined display characteristic in accordance with
the amount of collected ambient light.

20 2. The apparatus according to claim 1, wherein the
predetermined display characteristic includes transmittance,
the control circuit changing a minimum transmittance in
accordance with the amount of collected ambient light.

25 3. The apparatus according to claim 2, wherein the
liquid crystal display panel includes an electrode to which
a voltage of a predetermined range is applied, wherein the
control circuit shifts the predetermined voltage range in
accordance with the amount of collected ambient light to
thereby change the minimum transmittance.

30 4. The apparatus according to claim 3, wherein the
liquid crystal display panel is operated in a normally white
mode, and wherein the control circuit shifts the
predetermined voltage range to a high voltage range in order
to decrease the minimum transmittance when the amount of
collected ambient light is equal to or greater than a

predetermined value.

5. The apparatus according to claim 3, wherein the liquid crystal display panel is operated in a normally black mode, and wherein the control circuit shifts the predetermined voltage range to a low voltage range in order to decrease the minimum transmittance when the amount of collected ambient light is equal to or greater than a predetermined value.

6. The apparatus according to claim 1, wherein the predetermined display characteristic includes contrast ratio, the control circuit adjusting the contrast ratio of the liquid crystal display panel in accordance with the amount of collected ambient light.

7. The apparatus according to claim 6, wherein the liquid crystal display panel includes an electrode to which a voltage of a predetermined range is applied, and wherein the control circuit narrows the predetermined voltage range in order to decrease the contrast ratio when the amount of collected ambient light is equal to or greater than a predetermined value.

8. The apparatus according to claim 1, wherein the control circuit is connected to the light source, the control circuit turning off the light source when the amount of collected ambient light is equal to or greater than a predetermined value and turning on the light source when the amount of collected ambient light is less than the predetermined value.

5 9. The apparatus according to claim 1, wherein the luminescent unit includes a cover that moves between an open and closed position to selectively cover the light collector, and wherein the apparatus includes a cover driving apparatus connected to the control circuit to move the cover between the open and closed positions.

10 10. The apparatus according to claim 9, wherein the control circuit controls the cover driving apparatus such that the cover moves to the open position to expose the light collector when the amount of collected ambient light becomes equal to or greater than a predetermined value and moves to the closed position to cover the light collector when the amount of collected ambient light becomes smaller than a predetermined value.

20 11. The apparatus according to claim 9, wherein the control circuit is connected to the light source, and wherein the control circuit controls the light source and the cover driving apparatus such that the light source is turned on and the cover is closed when the amount of collected ambient light is equal to or smaller than a first predetermined value, the cover is opened when the amount of collected ambient light exceeds the first predetermined value, and the light source is turned off when the amount of collected ambient light exceeds a second predetermined value, which is greater than the first predetermined value.

30 12. The apparatus according to claim 11, wherein the predetermined display characteristic includes contrast ratio and transmittance, and wherein the control circuit decreases the contrast ratio and the minimum transmittance when the

amount of collected ambient light exceeds a third predetermined value, which is greater than the second predetermined value.

5 ~~13. The apparatus according to claim 1 further comprising a light receiving device connected to the control circuit, wherein the light receiving device generates a voltage signal corresponding to the amount of ambient light.~~

10 ~~14. The apparatus according to claim 13, wherein the light receiving device is located in the proximity of the light collector.~~

15 ~~15. A liquid crystal display apparatus comprising:
a liquid crystal display panel having a predetermined display characteristic;
a luminescent unit arranged adjacent to the liquid crystal display panel for providing light to the display panel to illuminate the display panel, wherein the luminescent unit includes a light collector, which collects ambient light, and a light source;~~

~~a light receiving device for generating a light amount signal corresponding to the amount of light illuminating the liquid crystal display panel; and~~

25 ~~a control circuit electrically connected to the liquid crystal display panel and the light receiving device, wherein the control circuit varies the predetermined display characteristic in accordance with the light amount signal.~~

30 ~~16. The apparatus according to claim 15, wherein the liquid crystal display panel includes:
first and second substrates;~~

a liquid crystal layer arranged between the first and second substrates; and

a sealed portion for sealing the liquid crystal layer and defining a peripheral area and a display area of the liquid crystal display panel, wherein the light receiving device is formed on one of the facing surfaces of the first and second substrates in the peripheral area.

17. The apparatus according to claim 15, wherein the liquid crystal display panel includes a pair of substrates, and wherein the light receiving device is arranged facing the luminescent unit on one of the substrates.

18. The apparatus according to claim 15, wherein the predetermined display characteristic includes transmittance, the control circuit changing the minimum transmittance in accordance with the light amount signal.

19. The apparatus according to claim 15, wherein the predetermined display characteristic includes contrast ratio, the control circuit changing the contrast ratio in accordance with the light amount signal.

20. A liquid crystal display apparatus comprising:
a liquid crystal display panel for displaying an image having a predetermined contrast ratio and brightness;
a luminescent unit arranged adjacent to the liquid crystal display panel, wherein the luminescent unit includes a light collector, which collects ambient light, a light source, and a cover, which opens and closes to selectively cover the light collector;

a cover driving apparatus for opening and closing the

cover;

SUB A3
a light receiving device for generating a light receiving signal corresponding to the amount of ambient light; and

5 a control circuit connected to the liquid crystal display panel, the light receiving device, the light source, and the cover driving apparatus, wherein the control circuit controls the ON/OFF of the light source, the opening and closing of the cover, and adjusts the contrast ratio and the
10 brightness in accordance with the light receiving signal.

21. The apparatus according to claim 20, wherein the control circuit includes:

15 a judgement circuit for generating at least one of a contrast ratio adjustment signal, a brightness adjustment signal, a cover driving signal and an ON/OFF signal in accordance with the light receiving signal;

20 a contrast ratio adjustment circuit connected to the first judgement circuit, the contrast ratio adjustment circuit processing an image signal to adjust the contrast ratio in accordance with the contrast ratio adjustment signal; and

25 a brightness adjustment circuit connected to the contrast ratio adjustment circuit and the liquid crystal display panel, the brightness adjustment circuit processing the image signal, which contrast ratio has been adjusted, to adjust the brightness in accordance with the brightness adjustment signal.

SUB A5
22. The apparatus according to claim 21, wherein the judgement circuit includes:

a first judgement circuit for receiving the light

SUBB57
receiving signal from the light receiving device and
comparing the light receiving signal with a first criterion
value to generate a contrast ratio adjustment signal;

5 a second judgement circuit for receiving the light
receiving signal from the light receiving device and
comparing the light receiving signal with a second criterion
value to generate a brightness adjustment signal;

10 a third judgement circuit connected to the cover
driving apparatus, the third judgement circuit receiving the
light receiving signal from the light receiving device and
comparing the light receiving signal with a third criterion
value to generate a cover driving signal; and

15 a fourth judgment circuit connected to the light
source, the fourth judgement circuit receiving the light
receiving signal from the light receiving device and
comparing the light receiving signal with a fourth criterion
value to generate an ON/OFF signal.

SUBA67
20 23. The apparatus according to claim 20, wherein the
control circuit includes:

a linear contrast ratio adjustment circuit for
receiving the light receiving signal and processing an image
signal to adjust the contrast ratio in a linear manner in
accordance with the light receiving signal;

25 a linear brightness adjustment circuit connected to the
linear contrast ratio adjustment circuit and the liquid
crystal display panel, the linear brightness adjustment
circuit receiving the light receiving signal from the light
receiving device and processing the image signal, which
30 contrast ratio has been adjusted, to adjust the brightness
in a linear manner in accordance with the light receiving
signal;

SUBA4

a first judgement circuit connected to the cover driving apparatus, the third judgement circuit receiving the light receiving signal from the light receiving device and comparing the light receiving signal with a first criterion value to generate a cover driving signal; and

a second judgment circuit connected to the light source, the fourth judgement circuit receiving the light receiving signal from the light receiving device and comparing the light receiving signal with a second criterion value to generate an ON/OFF signal.

5
10
15
20
25
30

24. The apparatus according to claim 20, wherein the control circuit includes:

an analog-to-digital converter connected to the light receiving device to convert the light receiving signal to a digital light receiving signal;

a judgment circuit connected to the analog-to-digital converter, the cover drive apparatus, and the light source, wherein the judgement circuit compares the digital light receiving signal with a first criterion value to generate a contrast ratio adjustment signal, compares the digital light receiving signal with a second criterion value to generate a brightness adjustment signal, compares the digital light receiving signal with a third criterion value to generate a cover driving signal, and compares the digital light receiving signal with a fourth criterion value to generate an ON/OFF signal;

a multiplier connected to the judgement circuit to multiply a digital image signal with the contrast ratio adjustment signal to adjust the contrast ratio thereof;

an adder-subtractor connected to the multiplier and the judgement circuit to perform summation and subtraction on

the digital image signal, which contrast ratio has been adjusted, with the brightness adjustment signal to adjust the brightness;

51B
075
a digital signal processing circuit connected to the adder-subtractor to perform a predetermined digital signal process on the digital image signal, which contrast ratio and brightness have been adjusted; and

10 a digital-to-analog converter connected between the digital signal processing circuit and the liquid crystal display panel to convert the processed digital image signal to an analog image signal.

25 The apparatus according to claim 20, wherein the control circuit includes:

an analog-to-digital converter connected to the light receiving device to convert the light receiving signal to a digital light receiving signal;

30 a multiplier connected to the analog-to-digital converter to multiply the digital image signal with the digital light receiving signal to adjust the contrast ratio thereof;

25 an adder-subtractor connected to the multiplier and the A/D converter to perform summation and subtraction on the digital image signal, which contrast ratio has been adjusted, with the digital light receiving signal to adjust the brightness; and

30 a judgement circuit connected to the analog-to-digital converter, the cover driving apparatus, and the light source, wherein the judgement circuit compares the digital light receiving signal with a first criterion value to generate a cover driving signal and compares the digital light receiving signal with a second criterion value to

generate an ON/OFF signal.

SUBAS

5 26. A liquid crystal display apparatus comprising:
a liquid crystal display panel for displaying an image
having a predetermined contrast ratio and brightness;
a luminescent unit arranged adjacent to the liquid
crystal display panel, wherein the luminescent unit includes
a light collector, which collects ambient light, a light
source, and a cover, which opens and closes to selectively
10 cover the light collector;
a cover driving apparatus for opening and closing the
cover;
a first light receiving device for generating a first
light receiving signal corresponding to an amount of ambient
15 light;
a second light receiving device for generating a second
light receiving signal corresponding to a total amount of
light illuminating the liquid crystal panel, which includes
the ambient light; and
20 a control circuit connected to the liquid crystal
display panel, the first and second light receiving devices,
the light source, and the cover driving apparatus, wherein
the control circuit controls the ON/OFF of the light source
and the opening and closing of the cover in accordance with
25 the first light receiving signal, and adjusts the contrast
ratio and the brightness in accordance with the second light
receiving signal.

30 27 The apparatus according to claim 26, wherein the
control circuit includes:

a judgement circuit for generating at least one of a
contrast ratio adjustment signal, a brightness adjustment

signal, a cover driving signal and an ON/OFF signal in accordance with at least one of the first and second light receiving signals;

5 a contrast ratio adjustment circuit connected to the first judgement circuit, the contrast ratio adjustment circuit processing an image signal to adjust the contrast ratio of the image signal in accordance with the contrast ratio adjustment signal; and

10 a brightness adjustment circuit connected to the contrast ratio adjustment circuit and the liquid crystal display panel, the brightness adjustment circuit processing the image signal, which contrast ratio has been adjusted, to adjust the brightness in accordance with the brightness adjustment signal from the second judgement circuit.

15 28. The apparatus according to claim 27, wherein the judgement circuit includes;

20 a first judgement circuit for receiving the second light receiving signal from the second light receiving device and comparing the second light receiving signal with a first criterion value to generate a contrast ratio adjustment signal;

25 a second judgement circuit for receiving the second light receiving signal from the second light receiving device and comparing the second light receiving signal with a second criterion value to generate a brightness adjustment signal;

30 a third judgement circuit connected to the cover driving apparatus, the third judgement circuit receiving the first light receiving signal from the first light receiving device and comparing the first light receiving signal with a third criterion value to generate a cover driving signal;

and

a fourth judgment circuit connected to the light source, the fourth judgement circuit receiving the first light receiving signal from the first light receiving device and comparing the first light receiving signal with a fourth criterion value to generate an ON/OFF signal.

29. The apparatus according to claim 26, wherein the control circuit includes:

a linear contrast ratio adjustment circuit for receiving the second light receiving signal from the second light receiving device and processing an image signal to adjust the contrast ratio in a linear manner in accordance with the second light receiving signal;

a linear brightness adjustment circuit connected to the linear contrast ratio adjustment circuit and the liquid crystal display panel, the linear brightness adjustment circuit receiving the second light receiving signal from the second light receiving device and processing the image signal, which contrast ratio has been adjusted, to adjust the brightness in a linear manner in accordance with the second light receiving signal;

a first judgement circuit connected to the cover driving apparatus, the first judgement circuit receiving the first light receiving signal from the first light receiving device and comparing the first light receiving signal with a first criterion value to generate a cover driving signal; and

a second judgment circuit connected to the light source, the second judgement circuit receiving the first light receiving signal from the first light receiving device and comparing the first light receiving signal with a second

ADD BIO7
add DT7

criterion value to generate an ON/OFF signal.

055230 0254400